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DISTRIBUTION OF FARM INCOMES UNDER ALTERNATIVE POLICY REGIMES A DYNAMIC ANALYSIS OF RECENT DEVELOPMENTS IN SOUTHERN BRAZIL (1960-1970)

by

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TABLE OF CONTENTS

Distribution of Farm Incomes Under Alternative Policy Regimes: A Dynamic Analysis of Recent Developments in Southern Brazil (1960-1970)*

I - Introduction

The purpose of this paper is to provide some insights into the impact of recent policies in Southern Brazil on the growth, distribution, and inequality of farm incomes for different farm sizes. We do this within the farmework of a dynamic model that was explicitly constructed to simulate regional development in Southern Brazil in the decade of the sixties. Besides simulating development under actual policy conditions that included a vast program of subsidy for wheat producers in the region, the model has been used to simulate this development under alternative pricing and credit policies. Although the model developed is capable of analyzing a vast compendium of economic variables such as regional resource use, factor productivities and factor proportions[1/] under alternative policy regimes, we limit our discussion here to the distribution of farm incomes and associated results provided by the model.

The importance of this short study is derived both from the far reaching impact of pricing policies in Southern Brazil in the past decade and from the vast differences in farm size and accompanying resource endowments in Southern Brazil. The result is a differential path

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* This report is part of a larger study of regional development in Southern Brazil being carried out under contract to USAID in the Department of Agricultural Economics and Rural Sociology, The Ohio State University.

1/ See Ahn and Singh [1972] for a complete set of results under actual historical conditions.

of development in response to these policy changes and resource endowments. The most important policy change in this decade centered around a government program initiated in 1962-63 to stimulate the production of wheat in order to reduce Brazil's reliance on foreign supplies. The program was institutionalized in 1963 and established the Bank of Brazil as official purchaser of wheat and provided a domestic support price above the world price starting in 1962. By 1970, the domestic price of wheat stood at a level nearly 80 percent above the U.S. export price (See Table 1). The wheat price subsidy which increased the ratio of wheat to beef prices in the domestic market compared to a relatively stable ratio in international markets was accompanied by a credit policy subsidizing the use of purchased inputs (such as certified seeds, fertilizer and farm inputs) that favored wheat production under a double cropping pattern in combination with soybeans, over the more traditional use of land for livestock production. The combined impact of these programs was to shift area out of traditional livestock enterprises to the intensive cultivation of wheat, resulting in a sevenfold increase in the area under cultivation and the domestic production of wheat.[2/]

This transition, which our model was able to capture in detail and upon which we and others report elsewhere, was accompanied by structural changes that involved the adoption of mechanized farming, the increased use of non-farm inputs, changes in the seasonal demand for labor, increased

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[2/] See Engler and Singh [1971].

Table 1. Domestic and Import Prices for Wheat and Beef in Brazil (1960-1970) In Cr$/Kilogram*

Year	WHEAT (unmilled) Brazil (domestic)[a]	WHEAT (unmilled) US Export Price[b]	BEEF (Chilled & frozen) (domestic)[c]	BEEF (Chilled & frozen) Export Price[b]	Ratio of Wheat to Beef Prices: Domestic Market	Ratio of Wheat to Beef Prices: International Market	Exchange Rate* Cr$/US$[d]
1960	0.0164	0.0127	0.072	0.0913	0.228	0.139	0.205
1961	0.0224	0.0207	0.104	0.1295	0.215	0.159	0.318
1962	0.04	0.0316	0.173	0.1692	0.231	0.186	0.475
1963	0.0647	0.0407	0.291	0.2387	0.221	0.17	0.620
1964	0.1446	0.1224	0.533	0.9659	0.271	0.126	1.850
1965	0.206	0.1333	0.627	1.407	0.329	0.095	2.220
1966	0.254	0.1378	0.721	1.339	0.352	0.103	2.220
1967	0.3005	0.1740	0.815	1.45	0.369	0.120	2.715
1968	0.3635	0.2358	0.849	2.117	0.428	0.111	3.830
1969	0.4265	0.2539	0.993	2.184	0.429	0.116	4.090[e]
1970	0.49	0.2793	1.10	2.7578	0.445	0.101	4.572[e]

* In New Cruzeiros/U.S.$.

Sources:

a) Annuario Estatistico do Brasil, 1960-1970, and Annuario Estatistico do Trigo, 1965-1969.
b) Yearbook of International Trade and Statistics, 1960-1970.
c) Annuario Agro-Pecuario, 1960-1970.
d) U.N. Statistical Yearbook.
e) Conjuctura Economica, vol. 17, no. 9, 1970.

credit use and a change in factor proportions.[3/] Our focus in this study, however, is on the impact of this transition upon the distribution of farm incomes among farms of different sizes in the region.

The questions we addressed ourselves to were the following:

1) Given initial differences in resource endowments and factor proportions, what initial differences in farm incomes and returns to family labor could we expect?

2) How would we expect farm incomes to grow over time, in the aggregate and for farms of different sizes?

3) What would be the initial distribution of farm incomes in the region, and changes in this distribution over time?

4) What are the inequalities in the distribution of incomes for farms of different size and have these inequalities changed over time?

5) Would the growth, distribution and inequality of incomes have been different if policies other than those pursued in the decade 1960-1970 had been followed? More specifically, what would have been the impact on farm incomes of an alternative set of policies involving the reduction of wheat and the increase of beef prices to international levels and less generous rules on the distribution of working capital?

[3/] See the series of project papers on regional development in Southern Brazil beginning with N. Rask [1969], [1971], [1972], B. Erven and N. Rask [1971], N. Rask, R. L. Meyers & F. Peres [1971], J. C. Engler [1971], J. C. Engler and I. J. Singh [1971] and papers related to the regional model C. Y. Ahn [1971], I. J. Singh and C. Y. Ahn [1972].

We attempt to answer these broad set of questions by simulating the model under different assumptions with respect to the price and credit policy parameters. The next section describes briefly the model we have employed and the policy parameters we simulate using this model: the third section is devoted to the dynamic simulation results on gross and net farm incomes and returns to family labor for different farm sizes we generate with the model; the fourth section is devoted to some general conclusions we are able to draw from our results suggestive of the types of impacts recent farm policies have had in Southern Brazil.

2. Model Description

The model used to investigate the issues set forth in the paper is a recursive programming model which uses the decomposition principle in linear programming to represent competition among farms of various size for regional resources. We describe the model here only briefly. A detailed mathematical exposition of the model can be found elsewhere.[4/]

We consider a region homogeneous with respect to agro-climatic conditions in which farmers maximize a short-run profit function. In order to incorporate differences in farm size we specify three farm size groups - small farms (0-50 hectares), medium farms (51-300) hectares, and large farms (300-10,000 hectares) - and assume that all farmers in the region belong to

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[4/] See C. Y. Ahn, [1971].

one of these groups, each with their own profit criteria and average on-farm constraints. Using the decomposition principle in linear programming and assuming separability and additivity, we are able to specify a regional objective function in terms of a set of farm activities.[5/]

Farm activities include production (wheat, soybeans independent and following wheat, corn, each at two levels of technology (traditional and modern) and beef cattle raised on either natural or improved summer and winter pastures); purchase (variable cash inputs such as hired labor, seeds, fertilizers, and livestock concentrates), financial (including savings, borrowings, and debt repayment) and investment (including the purchase of capital goods, combines and draft animals and some land improvement) activities. Intermediate transfer activities allow for the use of corn and pasture for livestock production and the conversion of natural to improved pasture or crop land.

We assume that the farmers choice of activity levels are constrained by physical, financial and behavioral limitations represented by a set of inequalities in each production period. The physical limitations include land, family labor, machine and draft animal capacities by season, type and farm size, and annual restrictions of seeds and fertilizers by farm size. These are aggregated for the region by farm size categories. The financial

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[5/] For the use of the decomposition principle see Dantzig [1963] and Lasdon [1970] among others. The assumption of separability implies that profits in one farm size group do not depend on the profits in another group, while additivity implies that both regional profits and regional resources are linear weighted sums of profits and resources in the various farm size groups.

limitations include a constraint on the working capital by farm size. In addition, there are limitations on the regional supplies of wage labor by season, credit and non-farm capital goods. These resources are available to all farms in the regions which compete for their use if they wish to augment their family labor, working capital or machine capacities. The inter-farm competition for these resources is incorporated through the use of regional coupling constraints leading to a structure where the diagonal farm size sub-matrices are bordered at the bottom by an array of non-empty matrices.[6/] Such a programming structure allows the use of the decomposition principle by coupling together almost separable sub-problems, one for each farm size group. Through these regional constraints. A set of balance equations allow the production of intermediate outputs and their transfer for use in final production or investment.

What distinguishes recursive programming models from similar static models is the incorporation of dynamic and behavioral parameters through the use of behavioral constraints and feedback.[7/] Behavioral constraints reflecting adoption and adjustment behavior include upper bounds on new technologies defining S-shaped diffusion paths through time and upper and lower crop flexibility bounds on individual crop acreages in any given year to reflect a "safety-first" criteria in response to risk and uncertainty.

[6/] See Lasdon [1970] for a detailed exposition of the decomposition principle and the implication of coupling constraints.

[7/] See Day [1963], [1965], [1967], Heidhues [1966], Day and Kennedy [1970]. Day and Tinney [1967], Singh [1971] and Mudahar [1971].

These constraints depend upon past decisions with regard to new technologies and land allocation to various crop outputs through a recursive feedback.[8/]

Additional dynamic elements introduced through feedback allow the augmentation and reduction of quasi-fixed capacities through investments previously made and depreciation and the growth in the labour force through time by farm size.

Financial constraints restrict cash availability by farm size group to previous years gross sales plus previous savings if any with accrued interest and non-farm incomes less cash outlays for production inputs, cash consumption expenditures and debt repayment of previous years borrowings. Short term borrowings are constrained on a regional basis by a proportion of the total regional farm sales in the previous year at a 15 percent nominal rate of interest.

The model is estimated by maximizing the regional objective function in each production period (a year), wherein the current parameter of the programming problem depends upon a sequence of previous decisions and initial exogenous data on regional land supply and family labour and input and output prices. Detailed data on input and output coefficients and on farm

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[8/] These safety criteria can be introduced as an axiom of behavior, Day [1965], or they can be derived from the safety first, Roy [1952], or focus-loss, Shackle [1958], principles of decision making under risk, Boussard [1969]. Petit and Boussard [1967]. For an early use in agricultural sector analysis see Henderson [1959] and Day [1963] and for detailed use in dynamic models of developing agriculture see Day and Singh [1971].

resources by farm size was constructed from a random sample of some 430 crop and livestock farms in the wheat region of Rio Grande do Sul. These were supplemented by information from field surveys, the Brazilian census and other published sources.[9/]

The region selected for this study included the areas of the Planalto Medio and Missoes in the state of Rio Grande do Sul in Southern Brazil. This region, fairly homogenous with regard to climate and agricultural practices covers some 5.7 million hectares of land under cultivation and accounts for over 60 percent of the total wheat production in Brazil.

3. Policy Assumptions for Model Simulations

Since our purpose was to analyze the impact of the most important policy changes in the decade (1960-1970), the focus rested upon the wheat price support program and the accompanying credit policies. The wheat price support program,by keeping domestic wheat prices above the international level, changed the domestic ratios of wheat to beef prices continually in favor of wheat (Table 1). This coupled with a program providing liberal credits for modern inputs which favored crop production allowed the expansion of wheat production, mainly at the expense of extensive livestock production. Whereas in the international markets the ratio of wheat to beef prices remained fairly stable, in the domestic market beef production could maintain its competitive edge only by increasing efficiency to offset the

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[9/] These include the Conjuctura Economica, Annuario Estatistico do Brazil, Trigo-Estudo do Custo de Producao among others. For details see Ahn [1971], and Engler [1971].

subsidies being granted wheat producers. This was partly done by those beef producers who were capable of transforming their extensive livestock operations into land intensive operations on improved summer and winter pastures. This required the increased use of modern variable inputs such as seed and nutrients. In addition to larger requirements of working capital such production required increasing amounts of investment capital for increasing the stock of breeding animals. Without a credit program that was specially designed to help this transformation, production of beef on improved pastures increased only slowly in the face of the improved profitability of wheat.

Wheat production on the other hand when tied with double-cropping of soybeans became continuously more profitable in the region. Thus more and more of the extensive livestock area was brought under crop cultivation devoted mainly to the production of wheat followed by soybeans. This transformation also required larger amounts of working capital for seed and nutrient inputs as well as investment capital to purchase machinery and equipment for land preparation, cultivation and harvesting, specially on larger farms. But by specifically providing very liberal credits for the purchase of modern inputs, by tying credit limits often to the volume of gross wheat sales (which were purchased by the Bank of Brazil, which also provided the credits) and by providing liberal terms on medium term loans for the purchase of machinery,[10/] these increased capital demands were easily met. The easiest and most profitable transition in the region was from extensive livestock production to wheat, and this occurred at an increasing rate, specially after 1965.

[10/] Very liberal terms indeed, Thus after 1964, modern variable inputs such as seed, nutrients, and pesticides could be purchased 100 percent on credit, while farmers could obtain long term, low interest financing for agricultural machinery with a 25 percent down payment at a 7 percent rate of interest. Meantime, the wholesale price index for foodstuffs increased by an average of 60 percent annually between 1960-66 and 23 percent a-nually between 1967-71. Thus in effect due to inflation the real rate of interest on credit was negative during the entire decade!

In the context of these policies three model simulations with the following policy assumptions were made for the period 1960-1970:

Assumptions for Run A: We assumed that the input and output prices that prevailed in the region were the historic domestic prices which included the price supports for wheat. In addition we assumed that liberal credit programs that actually prevailed in the period were in force. Thus modern variable inputs could be purchased on 100 percent short term credit which was available at a nominal interest rate of 15 percent per annum. Additional short term credit could also be applied against the purchase of other variable or quasi-fixed inputs, but all short term credit was repayable at the end of the production period with accrued interest. Further, the amount of institutional credit available was tied to the value of previous years gross sales and the regional credit limit was set at 60 percent of these sales (A rule of thumb used by credit institutions).

The purpose of these assumptions was to enable us to capture the historical path of regional development under actual policy and pricing conditions that prevailed during the decade. From the outcome of this run we could then estimate the initial income levels, their growth and distribution and their inequality among farm size groups, as they may have actually been in the decade of the sixties. This run therefore provides a benchmark of what occurred under actual policies followed.

Assumptions for Run B : We assume all input and output prices and credit programs as in Run A, except we substitute the prices that prevailed in international markets for wheat and beef (the U.S. export price for wheat and the Argentine export price for beef).

The purpose of these assumptions was to enquire what the impact would be of eliminating the price support programme for wheat by allowing domestic wheat prices to equal the international price. Since the main transformation involved the substitution of wheat for beef production, domestic wheat prices were also equalized to its international price.[11/] Run B therefore, provides the impact under an alternate set of price policies that would not specially favor wheat production.

Assumptions for Run C : We assume all input and output prices as in Run B, but we change the credit availability rule from a credit limit set at 60 percent of previous years gross sales to 10 percent of gross sales by farm size.

The purpose of this change in assumptions is to evaluate the impact of a far tighter credit program than the one that prevailed during the period in order to see whether credit restrictions were important if we allowed for wheat price supports.[12/] It was our implicit assumption

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[11/] Since domestic corn and soybean prices did not vary substantially from international prices, the assumptions in Run B are nearly equivalent to removing the barriers between domestic production and imports -- nearly because some price differentials would remain due to transportation and associated delivery costs. Domestic input prices, however, continue to prevail.

[12/] The supply of credit can be reduced by either raising the nominal interest rate or reducing the amounts available. Since in the dynamics of the model previous years debt obligations were paid out of previous years gross sales, the impact of inflation upon nominal interest rates was eliminated Thus, by reducing credit limits the supply schedule was shifted upwards even though the nominal interest rate remained constant. The credit limit was reduced by smaller steps than reported here, but these changes were not discrete enough to have a large impact.

justified partially by earlier work[13/] that credit demand increased substantially as a result of price supports to wheat and that credit restrictions without changes in the price support program would have little impact. Run C was designed to test this hypothesis.

4. Dynamic Simulation Results (1960-70)

The models estimated from 1960-70 generates a variety of data on resource use, productivity, factor proportions and technological change in the region. We concentrate here on the results pertaining to farm incomes.

Two broad income concepts are used in the analysis: 1) Farm incomes which are estimated on a gross or net basis by dividing the aggregate gross or net incomes by the number of farms in each size group; and 2) Returns to Family labour which are estimated by dividing the aggregate gross and net incomes by the number of hours of family labour employed in each size group. The farm income measure reflects differences in average farm size and resource endowments while the latter measure reflects the broad differences in per capita incomes that result from the farmer.

We first discuss the growth of total (gross) and net output under alternative policy assumptions for the region and by farm size; then we briefly review the implications of these growth rates on the distribution of output by farm size. Finally, we show the impact of varying policy assumptions on the inequality of farm incomes and returns to family labour.

4.1. Growth of Total (Gross) and Net Output by Farm Size

Total and net output by farm size and for the region as a whole estimated by the model under the three alternative policy assumptions are

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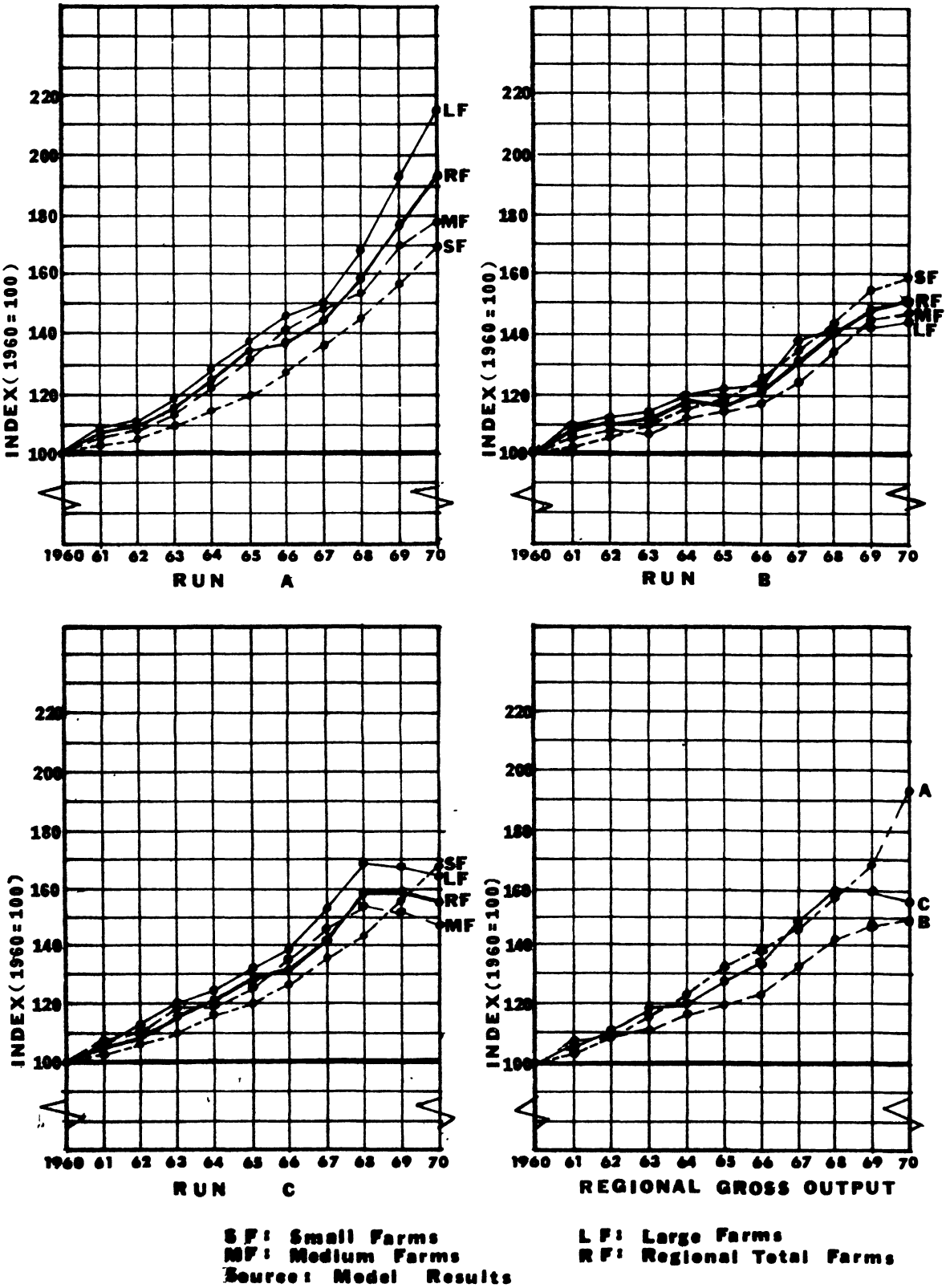
[13]/See Engler and Singh [1971], Ahn [1971], and Singh and Ahn [1971].

shown in figure 1 and 2 and the data on growth rates of total and net output are summarized in Table 2.

Under the assumption that historical pricing and credit policies prevailed the regional total and net outputs grew at compound rates of 6.8 and 8.1 percent per annum respectively. When the international prices of wheat and beef are substituted for the domestic support prices, the model estimated regional total and net outputs growing at 4.1 and 6.3 percent per annum respectively. Similarly, reducing the availability of credit from a 60 percent to a 10 percent rule had a similar impact, reducing the growth rates of total and net outputs to 4.6 and 6.4 percent per annum.

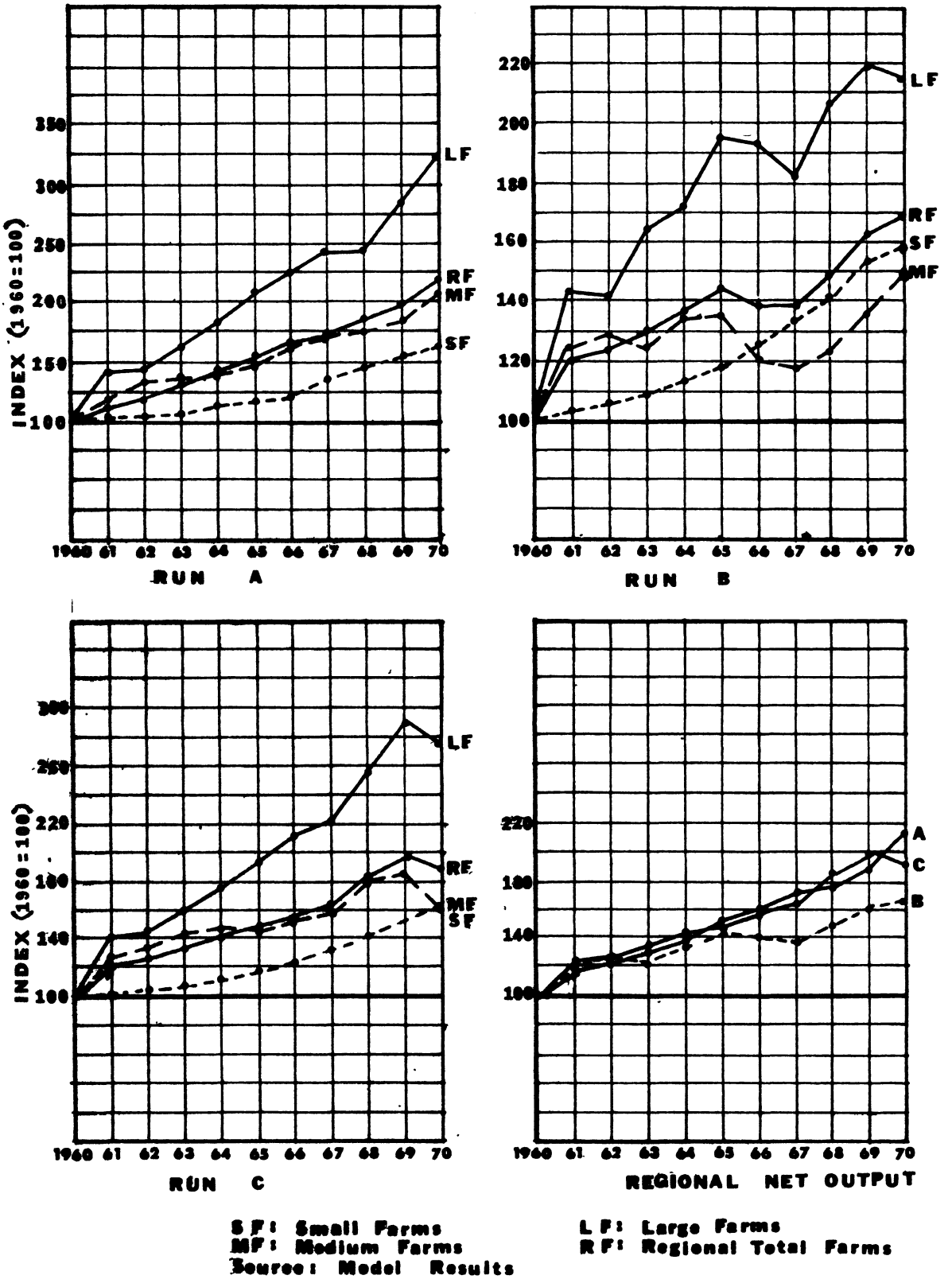
FIG. 1: GROSS OUTPUT BY FARM SIZE UNDER ALTERNATIVE POLICY ASSUMPTIONS



SF: Small Farms
MF: Medium Farms
LF: Large Farms
RF: Regional Total Farms
Source: Model Results

_Wheat Region in the State of Rio Grande Do Sul, Southern Brazil(1960-1970)

FIG.2: NET OUTPUT BY FARM SIZE UNDER ALTERNATIVE POLICY ASSUMPTIONS



SF: Small Farms
MF: Medium Farms
LF: Large Farms
RF: Regional Total Farms
Source: Model Results

Wheat Region in the State of Rio Grande Do Sul, Southern Brazil(1960-1970)

Table 2. Compound Growth Rates of Total and Net Output by Farm Size Estimated by Model Under Alternative Policy Assumptions*
(1960 - 1970)

I. TOTAL (GROSS) OUTPUT (At Constant 1970 Prices)

FARM SIZE	POLICY ASSUMPTIONS* A	B	C
SMALL FARMS (0 - 50 Hectares)	5.4%	4.8%	5.4%
MEDIUM FARMS (51 - 300 Hectares)	5.9%	3.9%	3.3%
LARGE FARMS (301 - 1500 Hectares)	8.5%	3.8%	5.4%
TOTAL REGIONAL	6.8%	4.1%	4.6%

II. NET OUTPUT (At Constant 1970 Prices)

FARM SIZE	POLICY ASSUMPTIONS* A	B	C
SMALL FARMS (0 - 50 Hectares)	5.4%	4.6%	5.0%
MEDIUM FARMS (51 - 300 Hectares)	7.5%	4.8%	5.1
LARGE FARMS (301 - 1500 Hectares)	12.4%	7.9%	10.7%
TOTAL REGIONAL	8.1%	6.3%	6.4%

*For definition of policy assumptions, see text.
Source: Tables 5 and 6.

Thus, both changes in the pricing and credit policies have a dampening effect upon the growth of regional output, reducing the growth rate of total output by nearly a third and the growth rate of net output by over a quarter from the rates experienced under historical pricing and credit policies. The domestic support pricing policies accompanied by the liberal availability of institutional credit can be said to have jointly been responsible for increasing the rates of growth of total farm output by one and a half times and of net output by nearly 1.3 times. A change in any one of these policies alone would not have increased these rates of growth of total and net farm outputs.[14/]

A closer examination of the estimated growth rates for different farm size groups shows the substantially different impact of these policies. Thus, providing price supports but keeping credit availability tight (assumption C) allowed total output on small as well as large farms to grow at a much faster pace than on medium farms, (5.4% vs. 3.3%), while net output grew at nearly double the rate on large farms compared to small and medium farms (10% vs. 5%). Alternatively, providing liberal credits but no price supports (assumption B) allowed total output to grow fastest on small farms and net output grew faster on medium than on small and on large than on medium farms.

Looking at the growth of total output under varying assumptions (B and C) comparing the results with those obtained under historical conditions (A) we conclude that the lack of price supports would have reduced growth rates on all farms, but most sharply on large farms, while the lack of liberal credits would have reduced growth rates on

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[14/] Thus, assumption B is equivalent to providing liberal credit but not price supports, while assumption C is equivalent to providing price supports but no credit.

medium and large farms though had no impact on small farms. Jointly, the price and credit programs have had the tendency of reversing the inverse relationship between high rates of growth of total output and farm size, by increasing the growth rates on medium and large farms more effectively than on small farms.

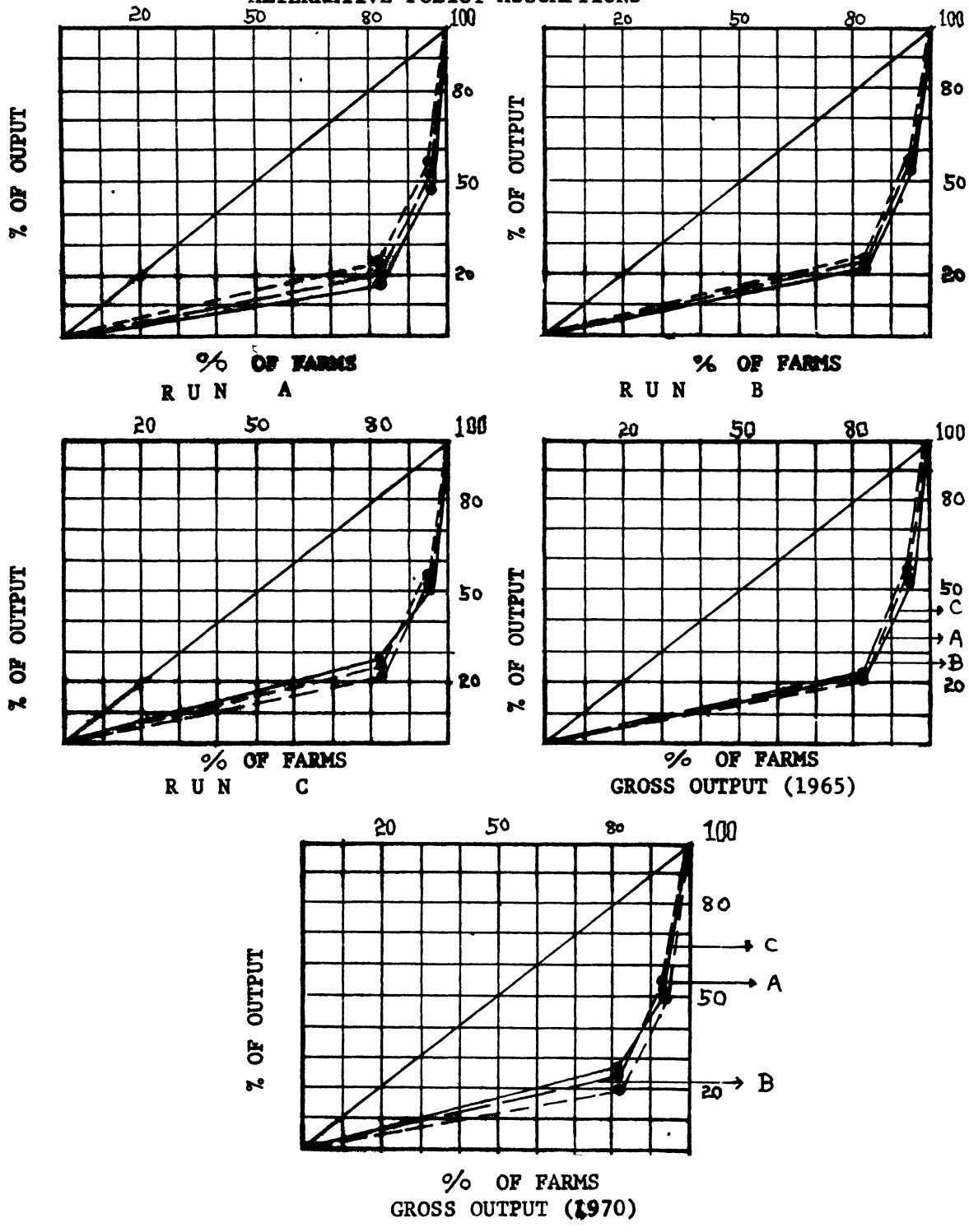
Looking at growth rates of net output we see that they are inversely related to size under all assumptions. However, the spread in their growth rates are the smallest under a policy of liberal credits (B) and largest under a joint program of price supports and liberal credit. We conclude, therefore, that the joint impact of the price and credit programs has been to substantially increase the differences in the inverse relationship between the rates of growth of net output and farm size. Thus, the larger the size of the farm, the greater has been the impact of the joint policies on the growth of net output.

4.2. Distribution of Total and Net Output By Farm Size

The distribution of total and net output by farm size estimated by the model are shown in figures 3 and 4 and the distributions for 1960 and 1970 under alternative policy assumptions are summarized in table 3.

The results indicate that under historical policy and credit policies (A) the share of large farms in both total and net incomes has been substantially increased while the share of small and medium farms reduced. Starting with 45 percent of total and 24 percent of net regional output in 1960, large farms had increased their share to 50 percent and 35.6 percent respectively. The greatest decline in the share of both total and net output was experienced by small farms.

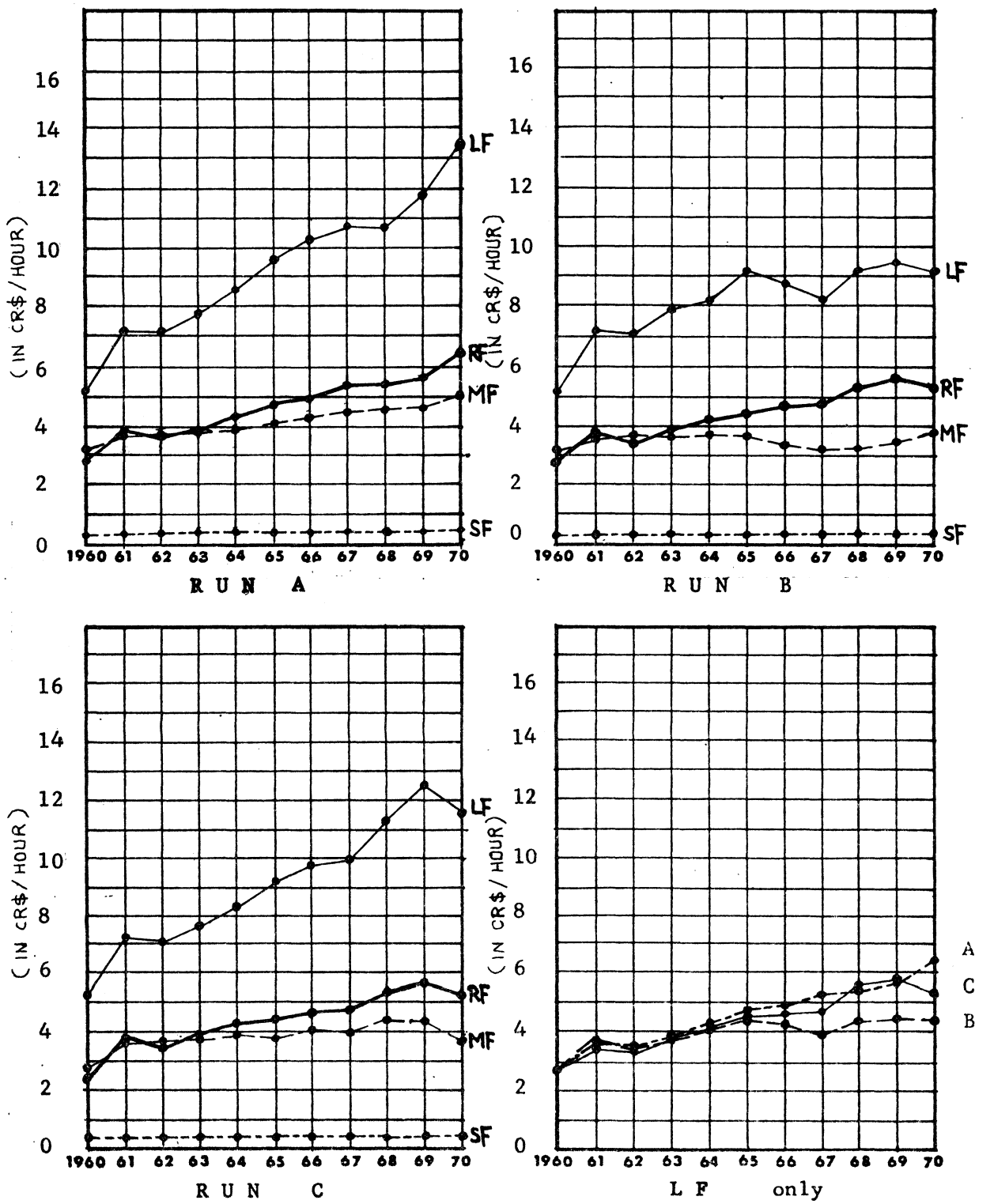
FIG. 3: DISTRIBUTION OF GROSS OUTPUT BY FARM SIZE UNDER ALTERNATIVE POLICY ASSUMPTIONS



Source: Model Results

Wheat Region in the State of Rio Grande Do Sul, Southern Brazil (1960-1970)

FIG. 4: NET RETURNS TO FAMILY LABOR HOURS AVAILABLE (IN CR$/HOUR) BY FARM SIZE



S F: Small Farms M F: Medium Farms L F: Large Farms
S F: Regional Total Farms

Source: Model Results

Wheat Region in the State of Rio Grande Do Sul, Southern Brazil(1960-1970)

Table 3. Distribution of Total and Net Regional Output by Farm Size Estimated by Model Under Alternative Assumptions (1960 & 1970)

I. PERCENTAGE OF TOTAL REGIONAL OUTPUT

	POLICY ASSUMPTIONS					
	A		B		C	
FARM SIZE	1960	1970	1960	1970	1960	1970
SMALL FARMS (0 - 50 Hectares)	22.4	19.6	22.4	24.0	22.4	24.2
MEDIUM FARMS (51 - 300 Hectares)	33.0	30.3	33.0	32.5	33.0	28.3
LARGE FARMS (301 - 1500 Hectares)	44.6	50.1	44.6	43.5	44.6	47.5

II. PERCENTAGE OF NET REGIONAL OUTPUT

	POLICY ASSUMPTIONS					
	A		B		C	
FARM SIZE	1960	1970	1960	1970	1960	1970
SMALL FARMS (0 - 50 Hectares)	35.7	27.0	35.7	33.3	36.8	31.5
MEDIUM FARMS (51 - 300 Hectares)	40.3	37.4	40.3	36.1	38.7	33.0
LARGE FARMS (301 - 1500 Hectares)	24.0	35.6	24.0	30.6	24.5	35.5

Source: Tables 5 and 6.

The impact of dropping price supports (B) on distribution of total output was to increase the share of small farms at the expense of medium and large farms, while restricting credit (C) increased the share of small and large farms at the expense of medium farms. The impact on net revenue, however, has been generally to increase the share of large farms under all assumptions at the expense of small and medium farms.

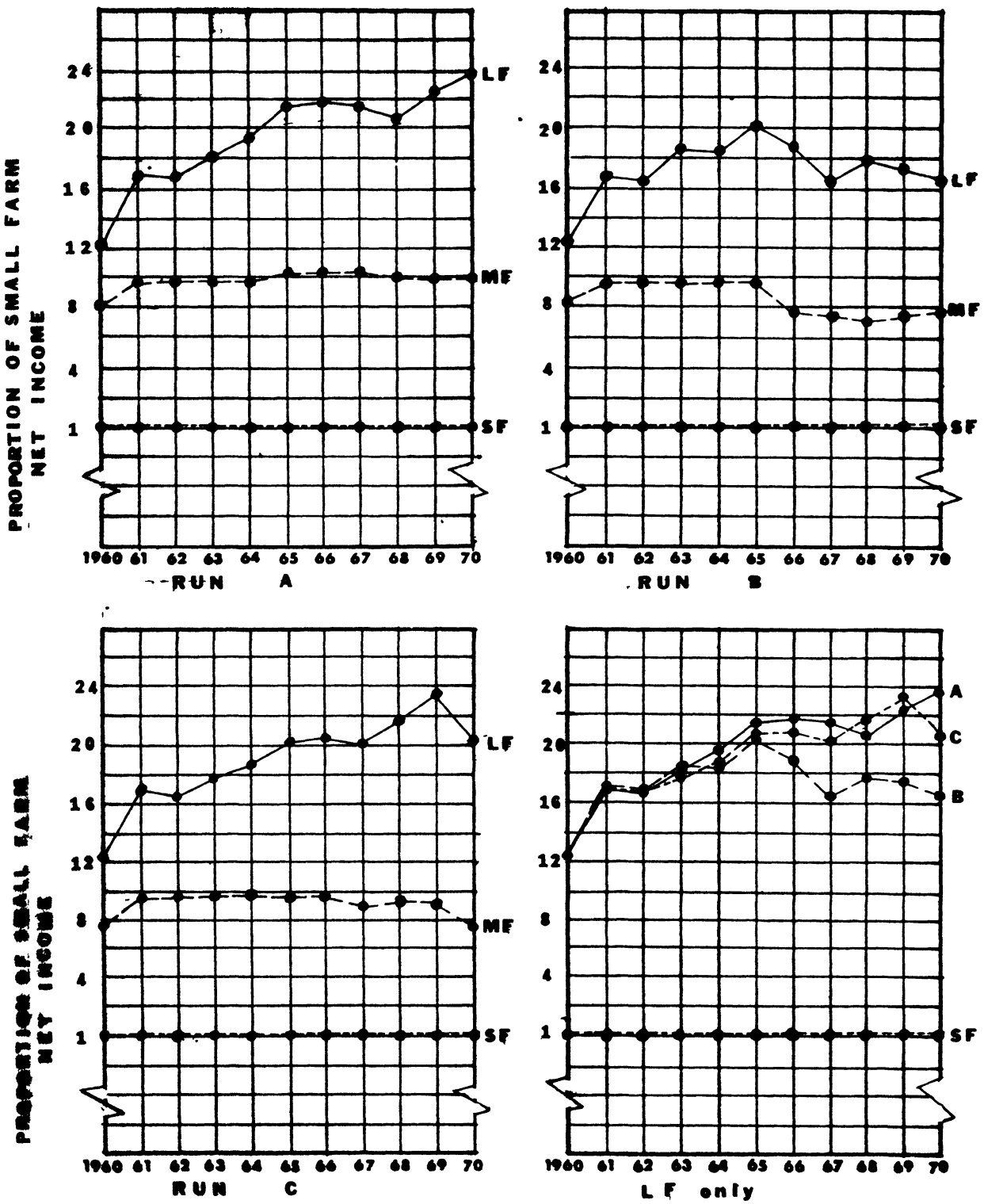
Thus, generally the joint impact of the price support and liberal credit programs has been to increase the share of large farms of both total and net output at the expense of medium and more specially small farms.

4.3. Inequality of Farm Incomes and Returns to Family Labour

Differences in the inequality of income are measured on the basis of a) average net farm incomes and b) average net returns to family labour. The model results on these two measures are shown in figures 5 and 6 and the results for two select years, 1961 and 1970, have been summarized in table 4, which shows farm incomes and returns to family labour as a proportion of farm incomes and returns to family labour on small farms respectively. This allows us to state medium and large farm incomes as a multiple of farm incomes on small farms and similarly for returns to family labour.

The results indicate that policy assumptions (A) under historical initially (1961) net farm income relative to farm incomes on small farms were in the order of 10 and 17 times greater on medium and large farms, while returns to families labour were about 11 to 21 times greater on medium and large farms respectively. These initial inequalities were the same under alternative policy assumptions.

FIG. 5: CHANGES IN NET FARM INCOME INEQUALITY

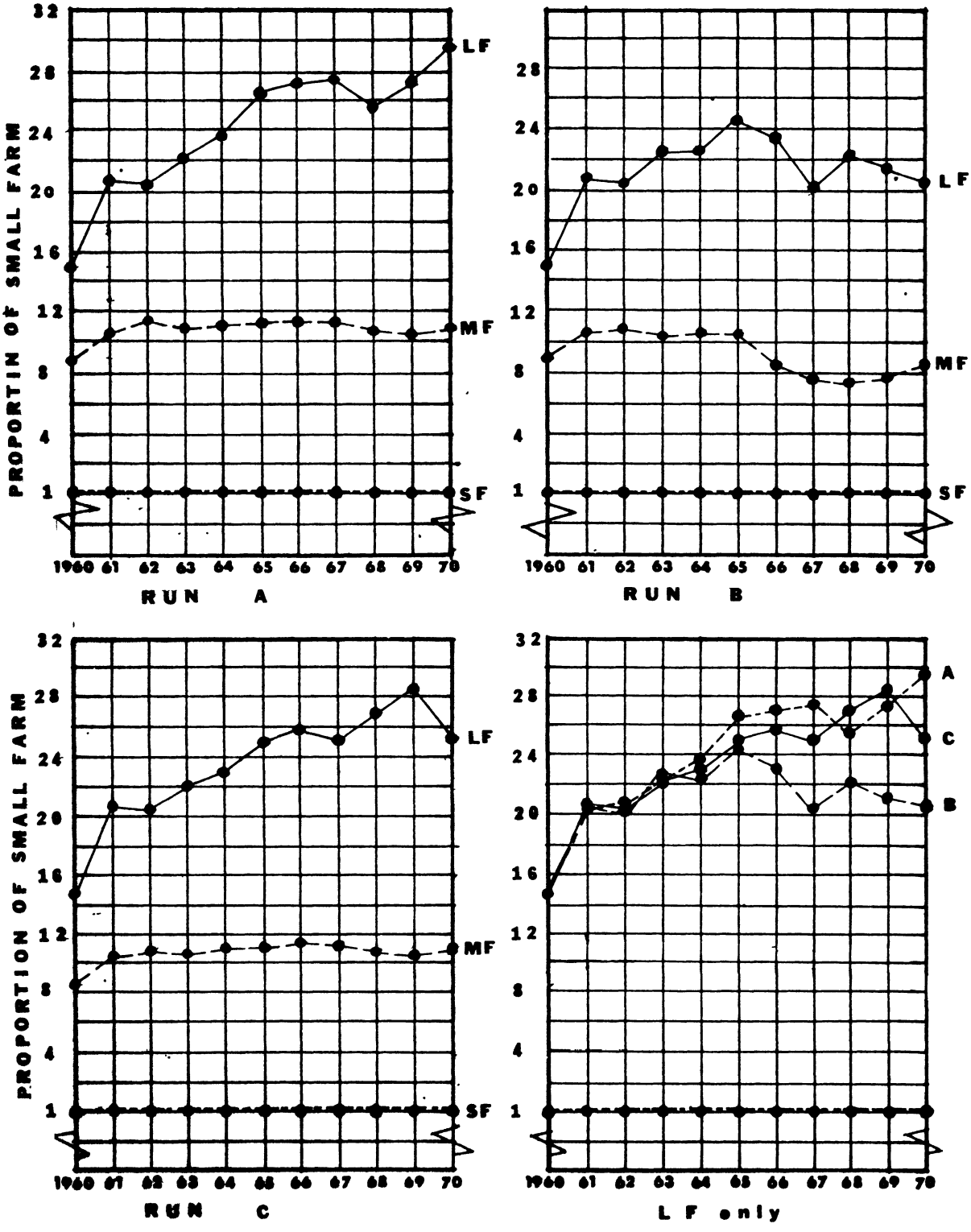


SF: Small Farms MF: Medium Farms LF: Large Farms

Source: Model Results

- Wheat Region in the State of Rio Grande Do Sul, Southern Brazil(1960-1970)

FIG. 6: CHANGES IN THE INQUALITY OF NET RETURNS TO FAMILY LABOR



SF: Small Farms MF: Medium Farms LF: Large Farms

Source: Model Results

Wheat Region in the State of Rio Grande Do Sul, Southern Brazil(1960-1970)

Table 4. Inequalities of Farm Incomes and Returns to Family Labour by Farm Size Estimated by The Model Under Alternative Policy Assumptions
(1961 & 1970)

I. NET FARM INCOMES AS A PROPORTION OF SMALL FARM NET FARM INCOMES

	POLICY ASSUMPTIONS					
	A		B		C	
FARM SIZE	1961	1970	1961	1970	1961	1970
SMALL FARMS (0 - 50 Hectares)	1.0	1.0	1.0	1.0	1.0	1.0
MEDIUM FARMS (51 - 300 Hectares)	9.69	9.88	9.7	7.5	9.6	7.5
LARGE FARMS (301 - 1500 Hectares)	16.92	23.95	16.9	16.7	16.9	20.4

II. NET RETURNS TO FAMILY LABOUR AS A PROPORTION OF SMALL FARM NET RETURNS TO FAMILY LABOUR

	POLICY ASSUMPTIONS					
	A		B		C	
FARM SIZE	1961	1970	1961	1970	1961	1970
SMALL FARMS (0 - 50 Hectares)	1.0	1.0	1.0	1.0	1.0	1.0
MEDIUM FARMS (51 - 300 Hectares)	10.7	10.9	10.7	8.6	10.6	8.3
LARGE FARMS (301 - 1500 Hectares)	20.8	29.4	20.8	20.5	20.8	25.1

Source: Tables 7 and 8.

However, when we consider the cumulative impact of various policies over time we get different results. Thus, whereas inequalities in farm incomes and returns to family labour remained fairly constant as between small and medium farms, the inequality increased substantially vis a vis large farms, under historical policy assumptions. When international prices for wheat and beef are introduced (B), the relative inequalities do not increase from the initial conditions but actually decline. Thus, net farm income differences decline from 9.7 to 7.75 times for medium farms and from 16.9 to 16.7 times on large farms. The decline in inequalities of returns to family labour are of a similar order. When credit restrictions are imposed (C), however, the inequality between small and medium farms declined, but between small and medium vis a vis large farms increased, though somewhat less than under historical policy conditions.

Thus, the joint impact of the price subsidies and liberal credit program was to increase the inequality of farm incomes and net returns to family labour between small and medium vis a vis large farms while preserving the relationship between small and medium farms. Had international wheat and beef prices prevailed there inequalities would not have increased, but would have been reduced substantially between small and medium farms, only slightly between small and large farms, but would have increased between medium and large farms. Restrictive credit with price supports would have increased the inequality between large and other farms, but would have reduced it between medium and small farms.

The main impact of price supports seems to have been to favor large farms vis a vis others, and small farms vis a vis medium size farms; while the main impact of liberal credits seems to have been in favor of small and medium farms vis a vis large favoring medium farms somewhat

more than small. However, we can conclude that the joint impact of the price support and credit policies followed in the decade of the sixties was to increase the farm incomes and returns to family labour on large farms relative to other farms. These relative increases were of the order that in another decade the initial inequalities in would nearly double.[15/]

5. Some Policy Considerations

In arriving at policy considerations from our current analysis it would be emphasized that the nature of our results are not exhaustive enough to pinpoint with accuracy the impact of any specific policy. In addition, the validity of our results depend crucially upon the validation of our model in its ability to capture the actual transformation in the region. We were unable to validate our model in a vigorous manner due to the lack of adequate time series data on regional resource use, factor proportions, factor productivity and income inequality by farm size. In addition, there are serious theoretical problems involved in the validation of such complex dynamic simulation models.[16/] However, a detailed analysis of the model results indicated that the model did indeed capture the main elements and direction of the transformation in the region during the decade of the study. Additionalconfirmation of the model was obtained

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[15/] Thus, in the decade 1960-70 large farm incomes increased from 17 to 24 times while large farm returns to family labour increased from 21 to 30 times relative to small farms - increases of 50% in the inequality.

[16/] Thus, for example there are several serious problems in evaluating simple dynamic and other econometric models for which the structural specifications are fully known. (See P. J. Dhrymes et al [1972]). However, dynamic simulation models of the type used in this study, which violate many of the assumptions regarding structural specification used in classical statistical inference, present even more insurmountable problems. (See S. R. Johnson and G. C. Rausser [1972]). For a serious attempt to test such a recursive programming model see Day and Singh [1971].

from experts familiar with the development process at the farm level in the region. These seem to indicate that the model did a remarkable job in capturing all the directions of change in resource use, factor proportions and productivities. However, pending further validation this limitation should be kept in mind, although even this does not invalidate the general care with which the model was constructed and the data collected to estimate it in order to capture the economic history of the region.[17/]

Keeping these limitations in mind, we can infer some important conclusions about the impact of policies upon the growth, distribution and inequality of incomes in the region. Briefly, the main results of the model indicate that:

(1) The price support policies accompanied by a liberal credit program were responsible for substantially increasing the rate of growth of both total and net output in the region in the decade of the sixties;

[17/] For a detailed exposition of the results, see Ahn and Singh [1971].

(2) The price support and credit programs have substantially increased the share of total and net output forthcoming from large farms at the expense of medium and specially small farms in the region;

(3) The price support and credit programs have substantially increased the inequality of farm incomes and returns to family labour of large farms relative to medium and small farms while preserving the relative inequalities between medium and small farms.

(4) In evaluating the relative importance of price and credit programs in bringing about these changes it is apparant that the main impact was due to the price subsidy programs, for restricting credits without removing price supports (assumption C) did not substantially effect either income distribution or income inequalities although it retarded the growth rates on medium and large farms, while removing price supports without restricting credits (assumption B) retarded not only the growth rates (even more than restricting credits) but also substantially changed the distribution of income in favor of small and medium farms and substantially reduced income inequalities. Thus, we would conclude that price supports were crucial in increasing the rates of growth of output, changing the distribution of income in favor of large farms and increasing the inequality of incomes between large vis a vis other farms.

In answering the question - what would have happened if price supports had not been provided, all other policies remaining unchanged? We conclude that the impact on regional rates of growth of output would have been similar to the removal of price supports, but the rates of growth would have been ratarded most on medium farms with no impact on small

farms; the distribution of total output would have been at the expense of medium farms, and the inequality of income between small and medium vis a vis large farms would continue to increase though the inequality between small and medium farms would be reduced.

It is difficult from these partial results to conclusively measure the impact of any given policy without a more detailed analysis of all the complex policy alternatives followed during the decade of the sixties. It is possible to give a broad indication of the impact of special policies upon the direction of changes in output, income distributions and income inequalities. This we have attempted to do within the framework of a dynamic regional model that attempts capture the strategic details of transformation in the wheat regions of this Grande do Sul.

APPENDIX

Table 5. Total Gross Output by Farm Size (in 1,000 Cr$ at 1970 prices): Wheat Region in the State of Rio Grande Do Sul, Southern Brazil (1960-1970)

Year	Small Farms	Medium Farms	Large Farms	Regional Total Farms
		Run A		
1960	96,344.5	141,893.62	191,914.25	430,152.37
1961	98,943.81	146,176.0	200,503.13	445,622.94
1962	101,917.25	153,419.25	213,496.81	468,833.31
1963	106,164.0	162,253.69	228,371.88	496,789.56
1964	110,939.81	173,141.69	248,889.38	532,970.88
1965	115,450.44	187,693.0	261,549.0	564,692.44
1966	122,272.19	201,333.0	273,373.5	596,978.69
1967	130,327.75	208,523.81	284,423.19	623,274.75
1968	140,032.25	217,744.38	322,433.5	680,210.13
1969	150,839.38	243,152.69	372,008.06	766,000.13
1970	162,829.38	251,526.63	416,104.88	830,460.88
		Run B		
1960	96,344.5	141,824.75	191,899.13	430,068.38
1961	98,943.8	146,704.44	200,480.19	446,128.44
1962	102,217.19	153,439.06	213,496.81	469,153.06
1963	106,164.0	154,213.06	215,242.63	475,619.69
1964	110,939.81	162,754.38	230,513.25	504,209.44
1965	115,450.44	162,823.75	234,995.44	513,269.63
1966	122,272.19	167,590.69	240,359.0	530,221.88
1967	130,350.63	178,334.31	261,741.562	570,426.5
1968	138,604.31	192,056.44	274,603.50	605,264.25
1969	149,310.69	206,583.75	275,901.06	631,795.5
1970	153,731.38	208,391.63	279,592.0	641,715.0
		Run C		
1960	96,344.5	136,503.25	191,758.31	424,606.06
1961	98,943.81	144,361.63	200,503.13	443,808.56
1962	102,202.06	150,546.44	213,446.81	466,195.31
1963	106,164.0	162,110.94	228,213.25	496,488.19
1964	111,211.63	160,575.25	239,204.25	510,991.13
1965	115,400.06	171,413.44	252,335.44	539,148.94
1966	122,236.5	183,104.25	263,154.0	568,494.75
1967	130,312.69	198,487.81	294,846.44	623,646.94
1968	139.981.88	212,568.75	324,532.88	677,083.5
1969	149,884.94	207,309.5	322,229.0	679,423.44
1970	161,008.94	188,557.13	316,173.0	665,739.06

Source: Model results.

Table 6. Total Net Output by Farm Size (in 1,000 Cr$ at 1970 prices): Wheat Region in the State of Rio Grande Do Sul, Southern Brazil (1960-1970)

Year	Small Farms	Medium Farms	Large Farms	Regional Farms Total
		Run A		
1960	61,939.08	69,811.69	41,387.94	173,138.75
1961	63,220.52	85,657.11	58,783.75	207,661.37
1962	64,920.23	90,606.56	58,720.88	214,247.69
1963	67,402.07	92,769.87	66,757.75	226,447.75
1964	70,185.11	97,795.87	74,660.00	242,641.00
1965	73,210.30	103,387.44	86,183.75	262,781.50
1966	77,240.48	110,955.75	92,939.82	281,136.06
1967	82,074.42	117,629.63	99,300.06	299,004.13
1968	87,933.11	121,212.12	100,794.44	309,939.69
1969	94,434.28	125,080.37	115,103.88	334,618.5
1970	101,673.82	140,424.58	133,840.81	375,939.25
		Run B		
1960	61,839.77	69,857.63	41,376.81	173,074.25
1961	63,211.96	85,891.16	58,764.87	207,868.00
1962	65,101.97	90,034.65	58,721.13	213,857.81
1963	67,400.97	87,217.69	67,686.94	222,305.62
k864	70,185.11	93,255.06	70,448.44	233,888.62
1965	73,210.30	94,735.07	80,810.75	248,756.12
1966	77,240.48	84,158.31	79,681.13	241,079.94
1967	82,093.92	82,702.30	75,546.88	240,343.19
1968	86,774.08	86,504.81	85,622.13	258,901.07
1969	94,053.57	95,093.13	90,946.44	280,093.19
1970	97,008.46	105,052.69	88,835.00	290,896.19
		Run C		
1960	61,983.0	65,254.19	41,292.56	168,529.75
1961	63,129.79	84,420.01	58,776.62	206,326.44
1962	65,037.88	88,110.42	58,690.50	211,838.81
1963	67,391.09	92,683.18	66,228.82	226,303.12
1964	70,404.75	97,590.79	72,643.44	240,639.00
1965	73,172.56	96,280.06	81,469.12	250,921.75
1966	77,207.29	102,689.75	88,928.88	268,825.94
1967	82,055.02	103,780.25	91,775.31	277,610.62
1968	87,904.37	118,753.75	105,753.12	312,411.25
1969	94,387.94	120,822.88	120,462.38	335,673.25
1970	101,497.73	106,088.37	114,021.07	321,607.19

Source: Model results.

Table 7. Average Net Farm Income by Farm Size as a Proportion of Small Farm Net Farm Income: Wheat Region in the State of Rio Grande Do Sul, Southern Brazil (1960-1970)

Year	Small Farms	Medium Farms	Large Farms
		Run A	
1960	1.0	8.06	12.16
1961	1.0	9.69	16.92
1962	1.0	9.98	16.46
1963	1.0	9.83	18.01
1964	1.0	9.96	19.36
1965	1.0	10.10	21.42
1966	1.0	10.28	21.89
1967	1.0	10.29	21.68
1968	1.0	9.86	20.86
1969	1.0	9.48	22.18
1970	1.0	9.88	23.95
		Run B	
1960	1.0	8.08	12.18
1961	1.0	9.72	16.92
1962	1.0	9.89	16.41
1963	1.0	9.26	18.39
1964	1.0	9.51	18.26
1965	1.0	9.26	20.09
1966	1.0	7.79	18.77
1967	1.0	7.23	16.49
1968	1.0	7.13	17.95
1969	1.0	7.23	17.60
1970	1.0	7.75	16.66
		Run C	
1960	1.0	7.53	12.12
1961	1.0	9.57	16.94
1962	1.0	9.69	16.42
1963	1.0	9.84	17.99
1964	1.0	9.92	18.78
1965	1.0	9.41	20.26
1966	1.0	9.51	20.96
1967	1.0	9.08	20.05
1968	1.0	9.66	21.89
1969	1.0	9.16	23.22
1970	1.0	7.48	20.44

Source: Model results.

Table 8. Average Net Returns to Available Family Labor Per Hour by Farm Size (in 1,000 Cr$ at 1970 prices): Wheat Region in the State of Rio Grande Do Sul, Southern Brazil (1960-1970)

Year	Small Farms	Medium Farms	Large Farms	Regional Total Farms
		Run A		
1960	0.3441	3.0632	5.1477	2.8516
1961	0.3443	3.6848	7.1678	3.7323
1962	0.3466	3.8219	7.0198	3.7294
1963	0.3528	3.8358	7.7676	3.9854
1964	0.3602	3.9643	8.5787	4.3010
1965	0.3683	4.1088	9.7086	4.7285
1966	0.3810	4.3231	10.2644	4.9895
1967	0.3969	4.4933	10.7518	5.2140
1968	0.4169	4.5393	10.6997	5.2186
1969	0.4389	4.5924	11.9639	5.6650
1970	0.4633	5.0546	13.6387	6.3855
		Run B		
1960	0.3435	3.0652	5.1463	2.8512
1961	0.3442	3.6948	7.1655	3.7348
1962	0.3476	3.7971	7.0198	3.7215
1963	0.3528	3.6062	7.9330	3.9640
1964	0.3602	3.7802	8.0948	4.0784
1965	0.3683	3.7649	9.1033	4.4121
1966	0.3810	3.2790	8.8001	4.1533
1967	0.3970	3.1591	8.1799	3.9120
1968	0.4114	3.2395	9.0891	4.2466
1969	0.4372	3.4914	9.4530	4.4605
1970	0.4421	3.7814	9.0525	4.4253
		Run C		
1960	0.3443	2.8632	5.1358	2.7811
1961	0.3438	3.6315	7.1670	3.7141
1962	0.3472	3.7160	7.0162	3.6931
1963	0.3528	3.8322	7.7621	3.9823
1964	0.3613	3.9560	8.3470	4.2214
1965	0.3681	3.8263	9.1775	4.4573
1966	0.3808	4.0010	9.8215	4.7344
1967	0.3968	3.9642	9.9371	4.7660
1968	0.4168	4.4473	11.2260	5.3633
1969	0.4387	4.4360	12.5209	5.7985
1970	0.4625	3.8187	11.6190	5.3000

Source: Model results.

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